

Applicant: Josefsson et al.  
For: CALIBRATION SYSTEM FOR A COMMUNICATIONS SYSTEM

1           1.       A calibration system for a communication system comprising  
2                       a transmitter circuit;  
3                       a receiver circuit;  
4                       a transmission medium having a transfer function for transmitting a  
5 transmission signal between said transmitter and receiver circuits; and  
6                       a calibration circuit responsive to an altered reference signal of said  
7 transmitter circuit altered by the transmission medium for adjusting the reference signal  
8 level of one of said transmitter and receiver circuits to compensate for variations in the  
9 transmission signal due to said transfer function.

1           2.       The calibration system of claim 1 in which said calibration circuit adjusts  
2 the reference signal level of both said transmitter and receiver circuits.

1           3.       The calibration system of claim 1 in which said transmission medium  
2 includes an isolation barrier circuit.

1           4.       The calibration system of claim 3 in which said transmitter circuit includes a  
2 digital to analog circuit having an analog output coupled to said isolation barrier circuit and  
3 an input for receiving an digital input signal to be communicated across said isolation  
4 barrier circuit and said receiver circuit includes an analog to digital circuit having an analog  
5 input coupled to the isolation barrier circuit for receiving the analog signal communicated  
6 across the isolation barrier and providing a digital output signal.

1           5.       The calibration system of claim 4 in which said digital to analog circuit  
2 includes a digital to analog converter with an input for receiving said digital input signal  
3 and a modulation circuit responsive to said digital to analog converter for providing said  
4 analog output.

1           6.       The calibration system of claim 4 in which said digital to analog circuit  
2 includes an encoder circuit responsive to said digital input signal to provide a digital signal,  
3 and a digital to analog converter responsive to said digital signal to provide to said isolation  
4 barrier said analog output.

1           7.       The calibration system of claim 4 in which said calibration circuit adjusts  
2 the reference signal level of both said transmitter and receiver circuits.

1           8.       The calibration system of claim 4 in which said analog to digital circuit  
2 includes an analog to digital converter responsive to said analog input from the isolation  
3 barrier circuit to provide a digital signal, and a decoder circuit responsive to said digital  
4 signal to provide said digital output signal.

1           9.       The calibration system of claim 4 in which said analog to digital circuit  
2 includes a demodulator circuit responsive to said analog input from the isolation barrier  
3 circuit to provide an analog signal and an analog to digital converter responsive to said  
4 analog signal to provide said digital output signal.

1           10.     The calibration system of claim 1 where the communication system is a bi-  
2     directional signal transfer system.

1           11.     The calibration system of claim 10 in which said calibration circuit adjusts  
2     the reference signal level of both said transmitter and receiver circuits.

1           12.     The calibration system of claim 10 in which said said transmission medium  
2     includes an isolation barrier circuit.

1           13.     The calibration system of claim 12 in which said isolation barrier circuit  
2     includes at least one isolation element; said transmission circuit includes a first digital to  
3     analog circuit having an analog output coupled to a first side of the isolation barrier circuit  
4     and an input for receiving a first digital input signal to be communicated across the isolation  
5     barrier and a second digital to analog circuit having an analog output coupled to a second  
6     side of the isolation barrier circuit and an input for receiving a second digital input signal to  
7     be communicated across the isolation barrier circuit; and the receiver circuit including a first  
8     analog to digital circuit coupled to the first side of the isolation barrier circuit for receiving  
9     the analog output of the second digital to analog circuit and a second analog to digital  
10    circuit coupled to the second side of the isolation barrier circuit for receiving the analog  
11    output of the first digital to analog circuit.

1           14.     The calibration system of claim 13 in which each of said first and second  
2     digital to analog circuits include a digital to analog converter with an input for receiving  
3     said digital input signal and a modulation circuit responsive to said digital to analog

4 converter for providing said analog output.

1 15. The calibration system of claim 13 in which each of said first and second  
2 digital to analog circuits include an encoder circuit responsive to said digital input signal to  
3 provide a digital signal, and a digital to analog converter responsive to said digital signal to  
4 provide to said isolation barrier said analog output.

1 16. The calibration system of claim 13 in which each of said first and second  
2 analog to digital circuits include an analog to digital converter responsive to said analog  
3 input signal from the isolation barrier to provide a digital signal, and a decoder circuit  
4 responsive to said digital signal to provide said digital output signal.

1 17. The calibration system of claim 13 in which each of said first and second  
2 analog to digital circuits include a demodulator circuit responsive to said analog input signal  
3 from the isolation barrier to provide an analog signal and an analog to digital converter  
4 responsive to said analog signal to provide said digital output signal.

1 18. The calibration system of claim 13 wherein the communication system is a  
2 simultaneous signal transfer system.

1 19. The calibration system of claim 18 further comprising a first echo  
2 cancellation circuit, producing a first echo cancellation signal, coupled to the first analog to  
3 digital circuit to remove the analog output of the first digital to analog circuit from the input

4 of the first analog to digital circuit, a first echo cancellation calibration circuit responsive to  
5 the altered reference signal of the first digital to analog circuit to adjust said first echo  
6 cancellation signal, a second echo cancellation circuit, producing a second echo cancellation  
7 signal, coupled to the second analog to digital circuit to remove the analog output of the  
8 second digital to analog circuit from the input of the second analog to digital circuit, and a  
9 second echo cancellation calibration circuit responsive to the altered reference signal of the  
10 second digital to analog circuit to adjust said second echo cancellation signal.

1 20. The calibration system of claim 19, wherein said first and second echo  
2 cancellation signals are derived from the analog outputs of said first and second digital to  
3 analog circuits, respectively.

4 21. The calibration system of claim 19, wherein the first echo cancellation signal  
5 is separately generated based on the first digital input signal and the second echo  
6 cancellation signal is separately generated based on the second digital input signal.

1 22. The calibration system of claim 21, in which each of said first and second  
2 echo cancellation circuits includes a digital to analog circuit with an input connected to said  
3 first and second digital input signals, respectively, and a voltage reference circuit, wherein  
4 said first and second echo cancellation calibration circuits adjust the voltage reference  
5 circuits based on the digital output signals of said first and second analog to digital circuits,  
6 respectively.

1           23.     The calibration system of claim 21, in which each of said first and second  
2 echo cancellation circuits includes a digital to analog circuit with an input connected to said  
3 first and second digital input signals, respectively, and a voltage reference circuit, wherein  
4 said first and second echo cancellation calibration circuits adjust the voltage reference  
5 circuits based on the altered reference signal of said first and second digital to analog  
6 circuits, respectively.

1           24.     The calibration system of claim 21 wherein the first echo cancellation circuit  
2 includes a digital to analog converter with an input connected to the first digital input signal  
3 and an output coupled to the input of the first analog to digital circuit and the second echo  
4 cancellation circuit includes a digital to analog converter with an input connected to the  
5 second digital input signal and an output coupled to the input of the second analog to digital  
6 circuit.

1           25.     The calibration system of claim 1 including a control circuit coupled to the  
2 transmission medium to synchronize the adjustment of the reference signal level.

1           26.     The calibration system of claim 25 in which the control circuit includes a  
2 clock circuit.

1           27.     The calibration system of claim 26 in which the control circuit includes a  
2 control channel.

1           28.     The calibration system of claim 2 including a control circuit coupled to the

2 transmission medium to synchronize the adjustment of the reference signal levels.

1 29. The calibration system of claim 28 in which the control circuit includes a  
2 clock circuit.

1 30. The calibration system of claim 29 in which the control circuit includes a  
2 control channel.

1 31. The calibration system of claim 4 in which the analog output is a constant  
2 average signal.

1 32. The calibration system of claim 4 in which the analog input is a constant  
2 average signal.

1 33. The calibration system of claim 4 wherein said calibration circuit includes a  
2 reference signal capture circuit for capturing an altered reference signal and providing said  
3 altered reference signal to said receiver circuit, wherein said altered reference signal  
4 compensates for variations in the transmission signal due to said transfer function.

1 34. The calibration system of claim 33 wherein said calibration circuit includes  
2 a reference signal averaging circuit connected to said reference signal capture circuit for  
3 averaging said altered reference signal and providing an averaged altered reference signal to  
4 said receiver circuit.

1           35.     The calibration system of claim 13 wherein said calibration circuit includes  
2     first and second calibration circuits, each of said first and second calibration circuits  
3     including a reference signal capture circuit for capturing an altered reference signal and  
4     providing said altered reference signals to said first and second receiver circuits  
5     respectively, wherein said altered reference signals compensate for variations in the  
6     transmission signals due to said transfer function.

1           36.     The calibration system of claim 35 wherein each of said first and second  
2     calibration circuits include a reference signal averaging circuit connected to said reference  
3     signal capture circuit for averaging said altered reference signal and providing an averaged  
4     altered reference signal to said first and second receiver circuits, respectively.

1           37.     The calibration system of claim 19 including a control circuit coupled to the  
2     transmission medium to synchronize the adjustment of the reference signal levels and the  
3     echo cancellation signals.

1           38.     The calibration system of claim 37 in which the control circuit includes a  
2     clock circuit.

1           39.     The calibration system of claim 38 in which the control circuit includes a  
2     channel control.